Unexpected occurrence of right to left shunt during lung perfusion scintigraphy: a problem-based learning exercise

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peer reviewed **CASE REPORT**

Unexpected occurrence of right to left shunt during lung perfusion scintigraphy: a problem-based learning exercise

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ABSTRACT

This case report presents a problem-based learning exercise that occurred during lung perfusion scintigraphy with technetium-99m macroaggregated albumin (^{99m}Tc-MAA) with the incidental finding of a previously undiagnosed right-to-left shunt. The pathology manifested with a redirection of ^{99m}Tc-MAA-loaded blood into systemic circulation and subsequent uptake in gastric, renal, and thyroid tissues. Incorrect radiopharmaceutical administration, radiopharmacy error and independent constituents of ^{99m}Tc-MAA offered alternative explanations which required exclusion. Subsequent recommendations included diligent use of safety procedures and appropriate documentation during receiving, dispensing and administration of radiopharmaceuticals. Clinical suspicion of RLS may warrant additional ^{99m}Tc-MAA imaging to confirm diagnosis or quantify severity.

Keywords VQ scan, ^{99m}Tc-MAA, nuclear medicine practitioner

LAY ABSTRACT

This case report provides an illustrated example of problem-based learning during a nuclear medicine lung imaging scan. The unexpected distribution of radioactivity within the stomach, kidneys and thyroid tissues required the attending nuclear medicine staff to provide a revised diagnosis of right-to-left cardiac shunt.

CASE REPORT

A 34 year-old female was referred for lung scintigraphy to exclude pulmonary embolism, having presented with symptoms including coughing, low oxygen saturation, raised lactate values and suspicion of sepsis. A SmartVent™ system (Diagnostic Imaging Ltd, England) was used during the ventilation phase to deliver 80 MBq technetium-99m diethylenetriaminepentaacetic acid (^{99m}Tc-DTPA). This was followed by intravenous administration of 127 MBq technetium-99m macroaggregated albumin (^{99m}Tc-MAA) for the perfusion phase. Planar imaging was performed for both phases; anterior, posterior, and left/right posterior oblique views (Figure 1). The ventilation phase showed normal distribution of radionuclide, the perfusion imaging demonstrated unusual uptake in gastric, renal and thyroid tissues. This was retrospectively explained as an anomalous left brachiocephalic drainage into the left atrium using computer tomography imaging from a previous hospital admission. Blood enriched with ^{99m}Tc-MAA was therefore partially redirected to systemic circulation and consequently interacted with extra-pulmonary organs. A diagnosis was then made of a right-to-left shunt (RLS).

DISCUSSION

An important aspect of optimal nuclear medicine service provision includes problem solving skills.[1] We present an example where due diligence and elimination of alterative causes aided in the confirmation of a RLS during VQ planar lung scintigraphy. The patient in this case report was diagnosed as exhibiting RLS with deoxygenating blood crossing into the left cardiac system, diluting the oxygenation being delivered to systemic tissues and resulting in hypoxia.[2]

Problem-based learning has been shown to be a popular method of teaching within diagnostic radiography.[3,4] Examples catering for nuclear medicine practitioners (NMPs) within academic literature are lacking. This case report, whilst elementary, addresses this gap by outlining the practical steps taken to overcome a problem encountered during clinical practice. The patient presented to the department with scant indication of RLS diagnosis. Unexpected radionuclide organ uptake necessitated a process of elimination by the NMPs to exclude alternative causes. Three potential alternatives were identified: incorrect radiopharmaceutical administration; errors during production of radiopharmaceutical; and disassociation of component parts thereof prior to administration to the patient.

The correct selection and administration of radiopharmaceuticals are listed as a key competencies for NMPs.[5] As such, the verification of originating vial with a fellow NMP is standard safety practice (known as 'double checking') which is a process replicated across many healthcare professions.[6] Within working practice this involves presenting the vial from which the radiopharmaceutical was taken, followed by confirmatory signature by both parties. Erroneous administration of radiopharmaceuticals has been raised as an area of concern, especially with instances of multi-patient vials lacking individualised identification methods (such as barcodes).[7] A second potential error may involve vials containing incorrect contents during radiopharmacy production, a circumstance limited by correct quality assurance procedures. Whilst unlikely, anecdotal experience by the authors warranted its investigation. Within this case report the wrongful administration of radiopharmaceutical was excluded due to appropriate safety procedures and documentation.

The uptake of activity outside of the

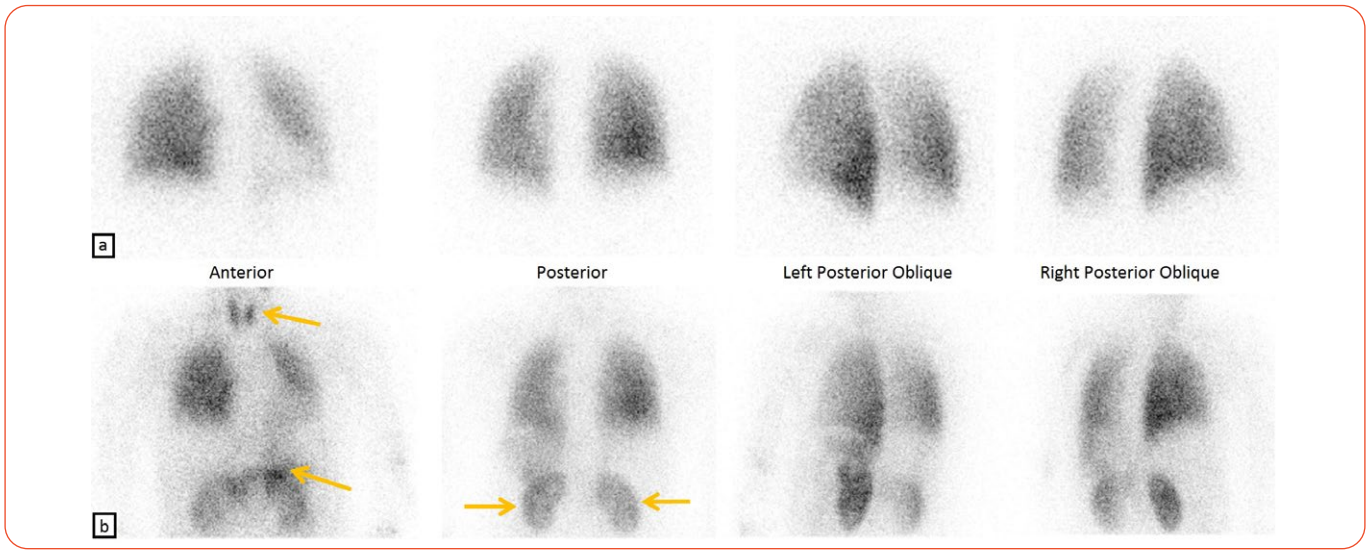

Figure 1. Planar lung scintigraphy (VQ). (a) Ventilation phase with normal distribution. (b) Perfusion phase with yellow arrows indicating unusual radionuclide uptake.

pulmonary system may be accounted for by free technetium-99m pertechnetate (^{99m}TcO4-) within the administered volume. In theory a disassociation between the radionuclide and pharmaceutical label in ^{99m}Tc-MAA would produce independent portions of ^{99m}TcO4-, ^{99m}Tc-MAA and MAA. A mixture of compounds within the same injected volume would produce uptake in multiple organs, with the distribution of MAA lacking radiological visualisation altogether. The presence of intravenous ^{99m}TcO4- may induce similar images to Meckel's diverticulum scintigraphy which has similar gamma camera scanning parameters (albeit a higher administered activity).[8] ^{99m}TcO4- has been used during first pass renal scintigraphy,[9] but would lack the visualisation of renal tissues. In terms of this presented case disassociation was excluded through chromatography by the radiopharmacy staff to ensure radiochemical purity.

Having eliminated all possible causes, the NMPs concluded that the imaging was a true representation of a previously undiagnosed pathology. This case report thus serves as exemplary practice by NMPs and demonstrates unusual RLS appearances during scintigraphic imaging.

CONCLUSION

The chance encounter of RLS within the nuclear medicine department was somewhat novel for the attending NMPs and was a useful problem-based learning exercise. Future cases of suspected RLS would benefit from an additional planar image of the patient's head to identity activity within the cerebral vessels with whole body imaging to quantify the severity of the shunt. The event in this case led to increased awareness of the pathology by local NMPs. It is a valuable confirmatory example of due diligence and care during the receiving, dispensing and administration of radiopharmaceuticals.

Although avoided within this case report, the incorrect administration or production of radiopharmaceuticals may be termed as a never event due to their preventable nature.[10] It is therefore advised that NMPs maintain vigilance at all stages of radiopharmacy production and use. Furthermore, suspicions of atypical pathologies such as RLS require close scrutiny of the patient's medical history and previous imaging to ensure a suitable and tailored imaging protocol.

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